Colorado River Basin Water Supply and Demand Study
Plan of Study

1. Introduction

The Bureau of Reclamation's Upper Colorado and Lower Colorado Regions (UC and LC Regions), in collaboration with representatives of the seven Colorado River Basin States (Basin States), submitted a proposal in June 2009 to fund the "Colorado River Basin Water Supply and Demand Study" (Study) under the Basin Study Program (Program). In September 2009, the Study was selected for funding under the Program. The estimated total cost of the Study is $2 million, with an equal cost-share of 50 percent by Reclamation and 50 percent by agencies in the Basin States (the non-Federal Cost-Share Partners). The Study will be conducted over a period of two years, beginning in January 2010.

This Plan of Study contains: the Study's purpose and objectives; a description of the Study management structure; a description of the major phases of the Study and a breakdown of the major tasks in each phase; a plan for public involvement throughout the Study (Attachment 1); and the June 2009 proposal (Attachment 2).

2. Study Purpose & Objectives

The purpose of the Study is to conduct a comprehensive study to define current and future imbalances in water supply and demand in the Colorado River Basin (Basin) and the adjacent areas of the Basin States that receive Colorado River water for approximately the next 50 years, and to develop and analyze adaptation and mitigation strategies to resolve those imbalances.

The Study will characterize current and future water supply and demand imbalances in the Basin and assess the risks to Basin resources. Resources include water allocations and deliveries consistent with the apportionments under the Law of the River[1]; hydroelectric power generation; recreation; fish, wildlife, and their habitats (including candidate, threatened, and endangered species); water quality including salinity; flow and water dependent ecological systems; and flood control. Specific objectives of the Study include:

- Characterization of the current water supply and demand imbalances in the Basin including the assessment of the risks to Basin resources from historical climate variability.

[1] The treaties, compacts, decrees, statutes, regulations, contracts and other legal documents and agreements applicable to the allocation, appropriation, development, exportation and management of the waters of the Colorado River Basin are often referred to as the Law of the River. There is no single, universally agreed upon definition of the Law of the River, but it is useful as a shorthand reference to describe this longstanding and complex body of legal agreements governing the Colorado River.

- Characterization of future water supply and demand imbalances under varying water supply and demand conditions in the Basin including the assessment of the risks to Basin resources from possible future impacts of climate change.
- Identification of potential strategies and options to resolve Basin-wide water supply and demand imbalances including:
    - Modifications to the operating guidelines or procedures of water supply systems;
    - Modifications to existing facilities and development of new facilities;
    - Modifications to existing water conservation and management programs and development of new programs;
    - Modifications to existing water supply enhancement programs and development of new programs; and
    - Other structural and non-structural solutions.
- Identification of potential legal and regulatory constraints and analysis of potential impacts to water users and Basin resources for the strategies and options considered.
- Prioritization of identified strategies and options and the recommendation for potential future actions, including feasibility studies, Congressional authorization, environmental compliance activities, demonstration programs, and/or implementation as appropriate.

3. Study Management

Management of the Study by the UC and LC Regions and the non-Federal Cost-Share Partners will be accomplished as described in the following sections.

3.1 Co-Study Managers

One Co-Study Manager will be designated from Reclamation and one Co-Study Manager will be designated from the Non-Federal Cost Share Partners. The Co-Study Managers will sit on and lead the Steering Team.

3.2 Steering Team

The Steering Team will steer and guide the efforts of the Project Team such that the objectives of the Study are met in an effective, efficient manner, and within the Study's financial and time constraints. The Steering Team will be comprised of one member from the UC Region, one member from the LC Region, one member from each Basin State, and one member from the Upper Colorado River Commission, for a total of 10 members.

3.3 Project Team

The Project Team will ensure that the tasks that relate to the Study are completed in a cost-effective, timely manner and are technically sound. Members of the Project Team provide the expertise, experience, and knowledge that relate to the Study's scope and objectives. Members include staff from the UC and LC Regions, staff from the non-Federal Cost-Share Partners, and staff from other entities who may be contracted to provide specific information, knowledge, and support. The Co-Study Managers will lead the Project Team.

3.4 Sub-Teams

Various Sub-Teams will be formed as needed to perform specific tasks. Sub-Team members provide specific expertise required to perform those tasks. Members are comprised of Project Team members, additional staff from the UC and LC Regions and the non-Federal Cost-Share Partners, and staff from contracted entities. Membership may also include representatives from other groups with a particular expertise sought by the Sub-Team.

3.5 Reclamation Management Structure

To facilitate Reclamation's oversight responsibilities and internal coordination, the proposed Study management structure includes a Reclamation Oversight Team (Oversight Team) and a Reclamation Study Team (Study Team). The Oversight Team provides oversight for the Study and will guide the efforts of the Study Team to ensure that the objectives of the Study are met within the financial and time constraints. Members of the Oversight Team are the Regional Directors of the UC and LC Regions and a senior member of the Office of Policy and Administration in Denver. Members of the Study Team include key staff from the UC and LC Regions.

4. Study Schedule, Phases, & Products

The Study will be technically oriented, incorporating information from the latest science, engineering technology, climate models, and innovations. The level of analysis of the strategies and options will be similar to an appraisal-level study to assist in justifying and preparing feasibility studies, Congressional authorization, environmental compliance activities, demonstration programs, and/or implementation as appropriate.

4.1 Schedule

The Study will be conducted over a period of two years, beginning in January 2010. The Study will consist of four major phases: Water Supply Assessment, Water Demand Assessment, System Reliability Analysis, and Development and Evaluation of Opportunities for Balancing Supply and Demand. The projected timeline for these phases is provided in Figure 1. The projected Study milestones are listed in Table 1.

Figure 1. Projected Study Timeline

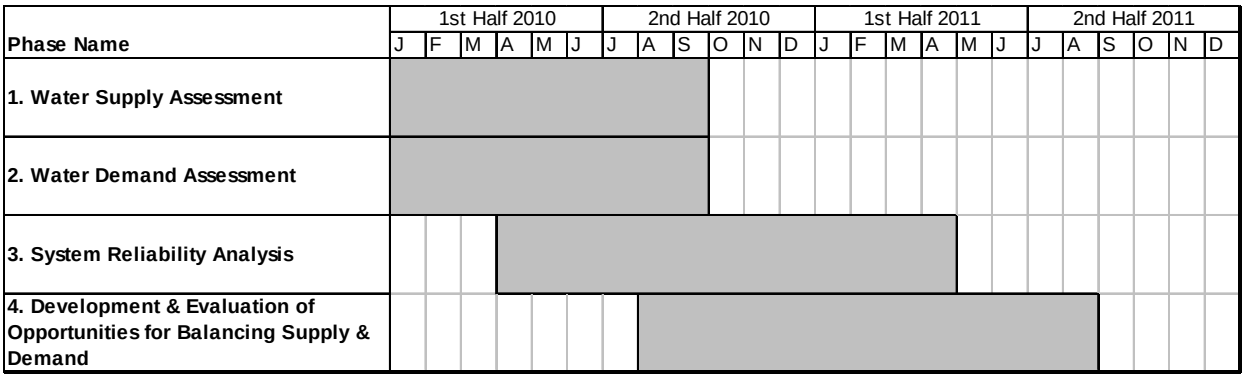


Table 1. Projected Study Milestones

Milestone	Deliverable Description
September 2010	Report describing findings from current and future water supply assessment
September 2010	Report describing findings from current and future water demand assessment
April 2011	Report describing findings from system reliability analysis
August 2011	Report describing findings of opportunities analysis
October 2011	Draft Study report and appendices available for review
December 2011	Final Study report and appendices complete

Development and review of the draft and final Study report will follow the completion of the fourth milestone as shown above.

4.2 Phases

Table 2 provides the tasks and sub-tasks associated with the major Study phases.

Table 2. Overview of Study Phases

Phase 1. Water Supply Assessment. Assess the quantity and location of current and future water supplies throughout the Basin, including the potential effects of climate variability and climate change. Major tasks and sub-tasks include: 1.1 Review & Select Methods to Estimate Current Supply 1.1.1 Historic Observed Record 1.1.2 Paleo Record 1.2 Review & Select Methods to Project Future Supply 1.3 Conduct Assessment of Current Supply 1.4 Conduct Assessment of Future Supply 1.5 Enhance Modeling Capability as Needed to Incorporate Methods to Project Future Supply 1.6 Conduct Sensitivity Analysis of Selected Methods to Project Future Supply 1.7 Prepare Draft Interim Report 1.8 Peer Review Report 1.9 Prepare & Publish Interim Report
Phase 2. Water Demand Assessment. Assess the quantity and location of current and future water demands, including the potential effects of climate variability and climate change. Major tasks and sub-tasks include: 2.1 Review & Select Methods to Estimate Current Demands 2.2 Review & Select Methods to Project Future Demands 2.3 Conduct Assessment of Current Demands 2.4 Conduct Assessment of Future Demands 2.4.1 Update State Demand Projections 2.4.2 Analyze Temperature Effects on Projected Use 2.5 Enhance Modeling Capability to Better Represent Future Demands 2.5.1 Reservoir Evaporation 2.6 Prepare Draft Interim Report 2.7 Peer Review Report 2.8 Prepare & Publish Interim Report

Phase 3. System Reliability Analysis. Assess the capability of existing and proposed infrastructure and operations to meet future demands and water supply challenges. This analysis will include an assessment of the operational risk and reliability of the system currently and in the future. System reliability will be determined by describing the quantity and locations of supply/demand imbalances currently and in the future. Scenarios for baseline and future water supply and demand will be determined in Phases 1 and 2. Evaluate effectiveness of opportunities identified in Phase 4 in resolving imbalances. Major tasks and sub-tasks include:

- 3.1 Identify Model & System Reliability Metrics
- 3.2 Determine Baseline System Reliability
  - 3.2.1 Determine Baseline Scenario Modeling Assumptions
  - 3.2.2 Prepare Model to Simulate Baseline Scenario
  - 3.2.3 Perform Model Simulations
  - 3.2.4 Synthesize & Analyze Model Results
  - 3.2.5 Summarize Model Results
- 3.3 Project Future System Reliability
  - 3.3.1 Determine Future Scenario Modeling Assumptions
  - 3.3.2 Prepare Model to Simulate Future Scenarios
  - 3.3.3 Perform Model Simulations
  - 3.3.4 Synthesize & Analyze Model Results
  - 3.3.5 Determine Modeling Assumptions for Supply/Demand Opportunities
  - 3.3.6 Prepare Model to Simulate Future Conditions Under Supply/Demand Opportunities
  - 3.3.7 Perform Model Simulations with Supply/Demand Opportunities
  - 3.3.8 Synthesize & Analyze Model Results
- 3.4 Prepare Draft Interim Report
- 3.5 Peer Review Report
- 3.6 Prepare & Publish Interim Report

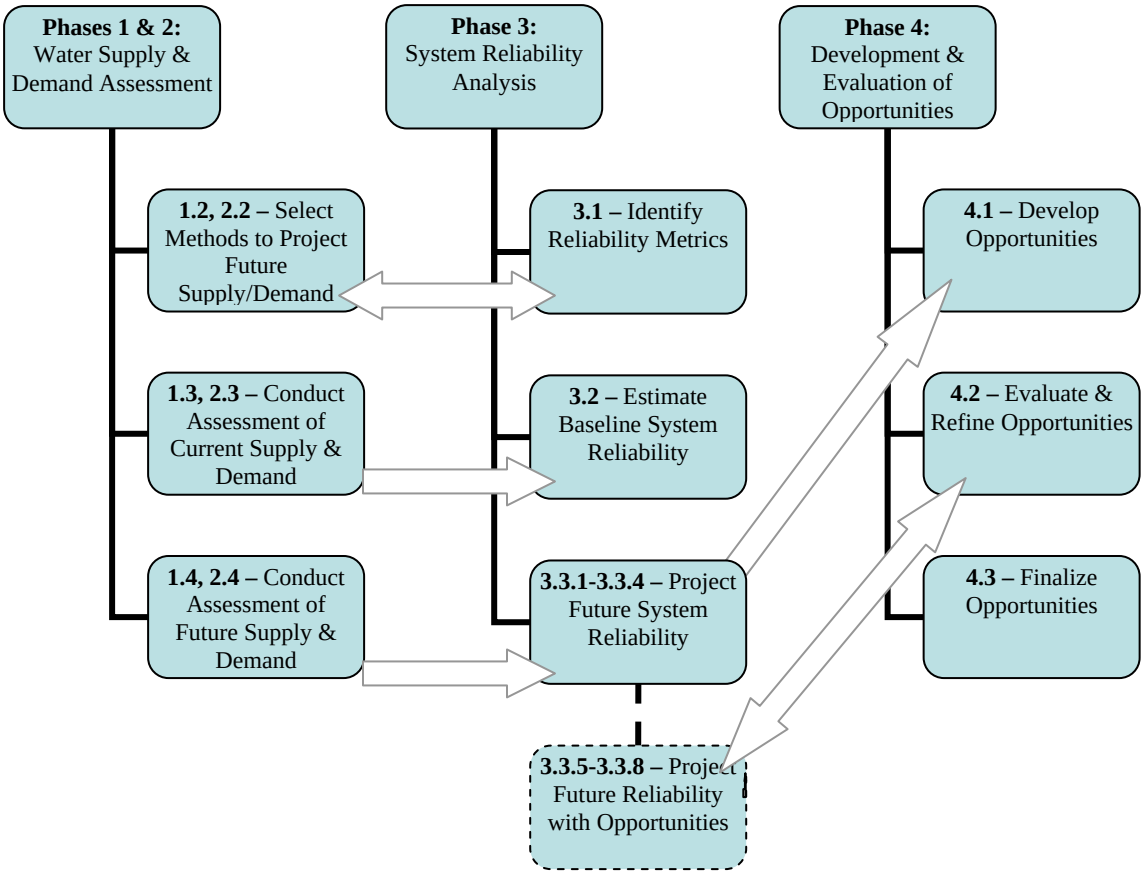
Phase 4. Development & Evaluation of Opportunities for Balancing Supply & Demand. Identify and quantify potential opportunities to address imbalances in supply and demand in order to best meet future challenges. This analysis will include the identification and development of both structural and non-structural opportunities. As opportunities are refined, an iterative modeling process will be used to determine future system reliability under conditions where selected opportunities are assumed to be developed and/or implemented. Opportunities include but are not limited to: operational changes, legal and institutional changes, water conservation and efficiency, land fallowing and retirement, conjunctive use, upgrades, rehabilitation or replacement of existing facilities, water recycling and reuse, desalination, development of new conveyance and storage facilities, weather modification, vegetation management, dust abatement efforts, groundwater remediation, urban runoff management, and importation projects. Major tasks and sub-tasks include:

- 4.1 Develop Opportunities
  - 4.1.1 Identify Opportunities
  - 4.1.2 Determine Preliminary Opportunities for Evaluation
  - 4.1.3 Analyze Opportunities (Preliminary)
- 4.2 Evaluate & Refine Opportunities
  - 4.2.1 Technical Feasibility
  - 4.2.2 Uniform Cost Comparison
  - 4.2.3 Environmental Impacts/Permitting Requirements
  - 4.2.4 Economic and Socioeconomic Impacts
  - 4.2.5 Legal and Public Policy Considerations
  - 4.2.6 Risk and Uncertainty

4.2.7 Others
4.2.8 Assessment of Effectiveness
4.2.9 Potential Yield
4.2.10 Timeframe for Implementation
4.2.11 Agreements or Partnerships Needed
4.2.12 Cost Allocation
4.2.13 Siting
4.3 Finalize Opportunities
4.3.1 Determine Ability of Opportunities to Resolve Imbalances
4.4 Prepare Draft Interim Report
4.5 Peer Review Report
4.6 Prepare & Publish Interim Report

Figure 2 illustrates the information transfer and coordination of tasks in the four major phases of the Study.

Figure 2. Flowchart of Major Study Phases



The first coordination occurs between Phases 1 and 2 and Phase 3 where the identification of the system reliability metrics in Task 3.1, in terms of spatial and temporal scale, depend upon the

methods selected to project future supply and demand in Task 1.2 and Task 2.2. Baseline and future system reliability in Task 3.2 and Task 3.3, respectively, is determined based on the results of the assessment of current and future water supply and demand conditions in Task 1.3 (and Task 2.3) and Task 1.4 (and Task 2.4).

In Task 4.1, opportunities to resolve supply/demand imbalance will be identified considering the results of the projections of future system reliability in Tasks 3.3.1-3.3.4. The evaluation and refinement of those opportunities in Task 4.2 will be accomplished through re-projecting future system reliability under the identified opportunities in Tasks 3.3.5-3.3.8. After several iterations consisting of refining opportunities and projecting system reliability to determine the opportunities' performance, opportunities will be finalized in Task 4.3.

4.3 Products

The primary products of the Study will be interim written reports to be integrated into a final report that will include the following elements:

- Assessment of quantity and location of existing and future water supplies and demands throughout the Basin, including the potential effects of climate variability and climate change,
- Assessment of efforts currently being undertaken to reduce supply and demand imbalances throughout the Basin,
- Analysis of supply and demand relationships and quantification of imbalances in specific locations throughout the Basin,
- Development and evaluation of options for balancing supply and demand,
- Findings and recommendations,
- Description of methods and research processes, including assumptions, models and data used in the Study, and
- Description of stakeholder involvement.

Other expected outcomes include the identification of collaborative strategies through the Study's stakeholder involvement process.

4.4 Public Involvement Plan

A Public Involvement Plan has been developed to ensure that all stakeholders in the Basin as well as the general public are informed and their input is sought and considered throughout the Study. The Public Involvement Plan is provided in Attachment 1.

5. Attachments

Attachment 1 – Colorado River Basin Water Supply and Demand Study Public Involvement Plan
Attachment 2 – Colorado River Basin Water Supply and Demand Study Proposal